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Date: *August 2, 2004*

To: *A. Sandorfi*

From: *E. Lessard, Chair, BNL Environment, Safety and Health Committee*
(Signature on File)

Subject: *LESHC 03-05, LEGS In-Beam Cryostat Replacement - Approval of Operation*

Reference: *1. BNL email, M. Lowry to E. Lessard, "LESHC 04-03 - Operations Permission", July 8, 2004.*

The Cryogenic Safety Subcommittee of the BNL Laboratory ES&H Committee (LESHC) reviewed the installation of a Physics Department Laser Electron Gamma Source (LEGS) In-Beam Cryostat Replacement in our meeting of August 4, 2003 (LESHC 03-05). The LEGS In-Beam Cryostat is a commercially available unit that replaces an existing unit and is located in the National Synchrotron Light Source LEGS Target Room (Room 168 of Building 725).

The Minutes contain two Committee Motions. Motion 1 documented several conditions that were required to be completed prior to the start of the In-Beam Cryostat commissioning process. Motion 2 presented additional Committee requirements that must be completed prior to the start of In-Beam Cryostat operations. A subsequent meeting (LESHC 04-03, April 8, 2004) reviewed the status of the commissioning prerequisites. All commissioning requirements were satisfied and permission to commence the commissioning process was granted in our memo of April 29, 2004.
The Minutes and related documentation are posted at:
http://www.rhichome.bnl.gov/AGS/Accel/SND/laboratory_environemnt,_safety_and_health_committee.htm.

Thank you for the recent email documenting the completion of all outstanding Committee requirements (Ref. 1). Based on our review of this submittal, approval for operation of the LEGS In-Beam Cryostat Replacement is granted, subject to the completion of any outstanding Physics or NSLS internal reviews.

CC (via Email):
LESHC Members, Meeting Attendees, S. Aronson, M. Bebon, M. Beckman, R. Casey, J. Ellerkamp, L. Hinchliffe (BHSO), T. Kirk, S. Musolino, J. Tarpinian, P. Yerry, M. Zarcone

Response to LESHC 04-03 Item 1.2.2.1

Implement LESHC 03-05 Conditions 1.2.2.1, 1.2.2.2 and 1.2.2.3, as appropriate for LEGS In-beam Cryostat operation. Kindly inform the LESHC Chairman and Secretary of the status of these issues prior to the start of operations.

> **LESHC 03-05 Item 1.2.2.1** – *Implement Conditions 1.2.1.1 and 1.2.1.2, as appropriate for LEGS In-beam operation.*
>
> > **LESHC 03-05 Item 1.2.1.1** – *Ensure that all personnel that are involved in the commissioning (including the Quantum Design representative) take the BNL "Cryogen Safety", "Oxygen Deficiency Hazards(ODH)" and "Static Magnet Field" training courses at http://training.bnl.gov/.*

The three courses are required for LEGS personnel and everyone is up to date. The Quantum Technology representatives are not involved in operations.

> > **LESHC 03-05 Item 1.2.1.2** – *Review the SBMS Subject Area "Oxygen Deficiency Hazards (ODH), System Classification and Controls" https://sbms.bnl.gov/standard/16/1600t011.htm, and perform the ODH calculations, both with and without the exhaust fans. Implement the appropriate control measures. Submit the calculations and proposed control measures to the LESHC Cryogenic Subcommittee for review.*

The calculations and proposed control measures were submitted to the committee and the appropriate changes were implemented prior to the start of commissioning as noted in memo to A. Sandorfi from E. Lessard of April 29, 2004.

> **LESHC 03-05 Item 1.2.2.2** – *Refer to the "Static Magnetic Field" Subject Area at https://sbms.bnl.gov/standard/1u/1u00t011.htm. Based on actual magnetic field strength measurements, implement the appropriate requirements.*
>
> **LESHC 03-05 Item 1.2.2.3** – *Verify compliance with the Static Magnetic Field SA for the hydrogen target transfer cryostat.*

The measurements, assessments and implentations of appropriate control measures were performed by Nicholas Gmur of the NSLS for all five of the current LEGS cryostats. A copy of the resulting "BNL Static Magnetic Fields Exposure Form" parts A, B and C is attached.

Response to LESHC 04-03 Item 1.2.2.2

Perform the in-situ quench test. (See 1.1.3 above.) Please transmit the results at the conclusion of the test.

> **LESHC 04-03 Item 1.1.3** – *LESHC 03-05 action item 1.2.1.3 states: "Perform a quench test to assure that the magnet vessel will not fail. Provide the results of this test to the Committee." The Committee reviewed the Physics Department Response. Two attempts were made at the factory, but both failed to quench the magnet. The BNL power supply is stronger and Physics committed to try an in-situ quench test (during commissioning), with the understanding that the device will not be put at risk for damage. The Physics Department will provide the results of this test to the Committee.*

An attempt to quench the Quantum Technology inbeam cryostat magnet was made during commissioning. Sawtooth ramping of the magnet at the maximum rate of the power supply failed to produce a quench at full current, 100 Amps. In an effort to warm the magnet, the cooling from the 2K pot was reduced and the snout magnet bath allowed to lose its liquid helium. The magnet did not quench before the automatic safety circuit took control and ramped it down to 10 Amps. At this current, the magnet did eventually quench with no effect on the operation of the refrigerator or damage to the apparatus. Disabling the safety circuit was viewed to put the device at risk. Thus we submit the requirement has been met.

BROOKHAVEN NATIONAL LABORATORY

BNL Static Magnetic Fields Exposure Form
Part A: Source Hazard Assessment Record

USE THIS FORM TO DOCUMENT MAGNETIC FIELD SOURCES THAT ARE AT OR EXCEED 0.5mT (5 GAUSS)
Line Managers or Principal Investigators, and ES&H Coordinators complete a separate form for each Static Magnetic Field source. This assessment applies to occupational exposures only. This assessment does not apply to unmodified consumer products (phones, computer terminals, magnetic stirring devices, refrigerator magnets, etc.) that are used as intended.

I. Source Identification

Department: NSLS (X5 beamline is run by the Physics Dept.)	**Building: 725A**	**Room or Area (location of source):** X5 Beamline; Rms. 1-168 and 1-169

Identifier/ Name of Source: X5 beamline solid HD cryostats

Status of Source Usage (check all that apply):
[X] In use on frequent basis [ ] Planned use in the near future [ ] Possible future use [ ] No planned use
[ ] Intermittent use [ ] One-time use [ ] Other:

Check or Describe Use or Process: [X] permanent magnet [ ] medical device [ ] Magnetic Resonance Imaging equipment
[X] Nuclear Magnetic Resonance equipment [X] super-conducting coils [ ] magnetometers [ ] accelerator magnets
[ ] detector magnets [ ] ion pumps [ ] electron microscope [ ] beam transport magnet [ ] electromagnet lifting device
[ ] other (specify):

II. Exposure Summary [Complete Part B: Field Strength Measurement Record *or* attach documentation from manufacturer]

Target Body Area	BNL Exposure Limits (mT)	(G)
Cardiac Pacemaker (Ceiling)	0.5	5
Ferromagnetic Objects (Ceiling)*	60	600
Torso or Head (Whole Body) (8-hour TWA)	60	600
Extremities (Limbs) (8-hour TWA)	600	6,000
Whole Body (Ceiling)	2,000 (2 T)	20,000
Extremities (Limbs) (Ceiling)	5,000 (5 T)	50,000

*Ferromagnetic Objects (Ceiling), including medical implants and prostheses, may be affected by fields. Additional evaluation is required.

Maximum Exposure Potential surveyed applicable to worker exposure:
Maximum fields surveyed were:
Dilution Fridge = 30 gauss in center at floor level (cryostat runs at 15 Tesla; almost entire cryostat is in an 8' deep pit); 5 gauss level is at ~6' distance. Workers cannot access body of cryostat unless unit is turned off, unit is brought up to room temperature and confined space procedure for access to pit is followed.
Storage Cryostat = 870 gauss at contact 24" above floor level (cryostat runs at 10 Tesla max field at the center of the superconducting (s.c.) solenoid; cryostat sits on floor fully exposed); 600 gauss at 19" from surface; 5 gauss at 60" from surface; 18 gauss at Caution tape at 36".
Transfer Cryostat = 175 gauss max
In-Beam Cryostat = 1 T max field at the center of the superconducting solenoid at end of tube; note that when tube is inserted into detector, personnel cannot make contact with this tube.
NMR equipment. The highest measured field strength does not exceed 2.1% of the exposure limits (see ESR for details on RF survey).

III. Exposure Hazard Evaluation [Check all that apply]

1. [ ] **Field Strength does not exceed 0.5mT (5 Gauss). Go to section V.**

2a. [ ] **Field strength is at or exceeds 0.5 mT (5 Gauss). No potential for individuals with medical electronic devices to be exposed above exposure limits. Explain in line 4.**
2b. [ ] **Field strength is at or exceeds 0.5 mT (5 Gauss). Individuals with medical electronic devices* may be affected. List users of cardiac pacemakers and other medical electronic devices in Part C: Employee Exposure Record.**

BROOKHAVEN NATIONAL LABORATORY

BNL Static Magnetic Fields Exposure Form
Part A: Source Hazard Assessment Record

3a. [X] **Field strength is at or exceeds 60 mT (600 Gauss) but for less than 8 hours TWA. No individuals with medical electronic devices* or ferromagnetic implants/prostheses** present.**

3b. [ ] **Field strength is at or exceeds 60 mT (600 Gauss) but for less than 8 hours TWA. Individuals with medical electronic devices* or ferromagnetic implants/prostheses** may be affected. List users of medical electronic devices or ferromagnetic implants/prostheses in Part C: Employee Exposure Record.**

3c. [ ] **Field strength is at or exceeds BNL Exposure Limit (8-hr. TWA or ceiling limit). No potential for individuals to be exposed above BNL Exposure Limit. Explain in line 4.**

3d. [ ] **Field strength is at or exceeds BNL Exposure Limit (8-hr. TWA or ceiling limit). Potential for individuals to be exposed above BNL Exposure Limit. List the names of individuals in Part C: Employee Exposure Record.**

* Medical electronic devices includes cardiac pacemakers, electronic inner ear prostheses, insulin pumps.
** Ferromagnetic implants/ prostheses includes aneurysm clips, replacement hips.

4. Describe job/task and potential for employee exposures (e.g., type of work performed around source, method of control, time spent in fields [hours/day] and method of determining exposure):
The cryostats are used for manufacturing solid HD targets, storing the targets, transporting the targets and positioning the targets in the gamma beam for analysis.
The X5 facility as a whole is posted for magnetic fields. Each unit is also posted with specifics. Barriers are placed around the storage cryostat (SD) during operation to keep personnel well away from the high fields at contact. The dilution fridge is located in an 8' pit and poses no hazards at the floor surface. The transfer cryostat fields are ~5 gauss at contact. The highest fields for the in-beam cryostat are at the end of the tube where fields reach 950 gauss at contact (not accessible to personnel when tube is inside detector) but decrease top 60 gauss at 5" and 5 gauss at 15".
Personnel frequently are in the areas around the cryostats working on electronics and other experimental equipment. When the HD targets are exposed to the gamma beam, personnel are interlocked out of this area due to the radiation hazard.

5. Frequency of exposure (e.g., # days per year or month, # tests per year, in continuous use, etc.):
Dilution fridge runs almost constantly. Other cryostats run as needed during experimental runs. The transfer cryostat is used only when a solid HD target is to be moved between dewars. This occurs at a frequency of a few times per year. Its magnet stays energized for about one hour during each target transfer. The in-beam cryostat operates only when it is holding a target in the beam.
Except for a short time (~1 hr) during target transfer, the In-Beam cryostat is inserted in the middle of a large detector system (SASY) while the magnet is energized. This constitutes a physical barrier that forces personnel to stay meters away from the superconducting magnet.
The Storage Dewar is anticipated to run for about six months/year over the next two years. However, personnel need to stay close to the SD, i.e. within the posted magnetic field physical barriers, only for the time necessary (a few minutes) to connect liquid helium and liquid nitrogen transfer lines. This occurs once every 2 days when the SD magnet is energized.

IV. Precautions / Engineering & Administrative Controls

Precautions During Use (check all that apply):
__X_ Signs
___ Lights
__X Barriers
___ Restricted access
___ Rotation of workers
__X_ Working when de-energized
___ Use of nonferromagnetic tools
___ Physical indicator of fringe fields (e.g., use of string with paper clips or equivalent)

Other:
Exhaust fans are available for the hydrogen (HD) targets (these fans are explosion proof) and for ODH conditions. Alarms for these fan systems are local and in the NSLS Control Room. Procedures for reacting to alarms are in place and personnel have been trained.

Written Documentation:
__X_ Experimental Review (Work Planning and Control for Experiments and Operations Subject Area)
___ Work Planning and Control (Work Planning and Control for Experiments and Operations Subject Area)
__X_ Written SOP (describe): All cryostats were originally reviewed by the BNL Cryogen Safety Committee and the NSLS ESH Committee. Recently, a revised In-Beam Cryostat was reviewed by the BNL Cryogen Safety Committee.

Other workers who may require information/written documentation/training to enter this area:
All personnel listed on the SAF and who work in the X5 experimental areas.

BNL Static Magnetic Fields Exposure Form
Part A: Source Hazard Assessment Record

Checklist:

Employee training required: __X__ Static Magnetic Fields Web Course __X__ Dept/Division-Specific Training

Supervisors training required: __X__ Static Magnetic Fields Web Course __X__ Dept/Division-Specific Training

The Dept./Div. training is administered by the X5 staff.

Training required to be linked in Job Training Analysis for affected work groups / job classifications: __X__yes ____no

Staff are linked to JTA #GE-12 – Static magnetic field training.

Medical approval required for individuals with medical electronic devices ____yes ____no

Medical review required for individuals above 8-hour TWA or ceiling ____yes ____no

N.A. for both at this time.

V. Initial Assessment	
Completed by: Nicholas F. Gmür	**Date:**
Reviewed by ES&H Coordinator:	**Date:**
Forward the original form to the Static Magnetic Fields Subject Matter Expert, copies to your ES&H Coordinator and Facility Support Representative. Retain a copy in your files. Update and resubmit the assessment when changes occur.	

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BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

Field Strength Measurement Record	
DATE: 8/18/2003	**SURVEYOR: R. Zantopp, assisted by Chris Bade of X5 staff.**

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-169
SOURCE: X5 Dilution Fridge		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS __X_ OTHER: Cryostat held in 8' deep pit in concrete. Signs on surface of apparatus. Confined space procedure required for entry into pit.		

II. SURVEY INSTRUMENT INFORMATION

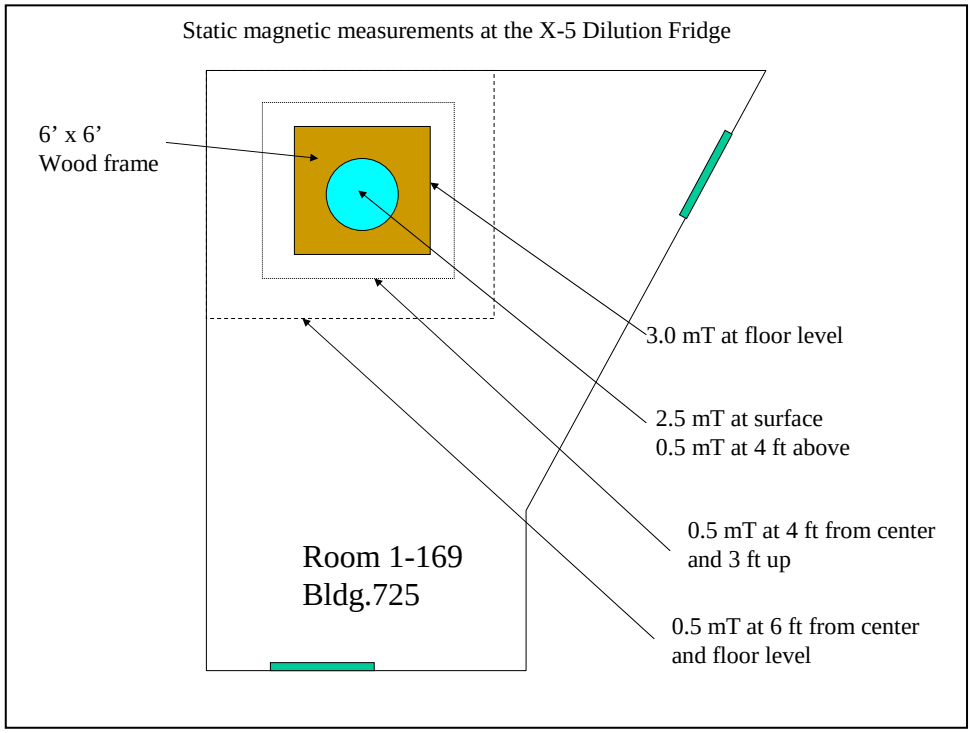
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 10/28/2002	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-169	See below	Magnet operating at 15 Tesla



BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

Continuation of Section III.

Field Strength Measurement Record	
DATE: 10/29/2003	**SURVEYOR: Rudy Zantopp**

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 storage cryostat with superconducting magnet (Janis Research Corp.)		
CONTROLS: __X_ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION

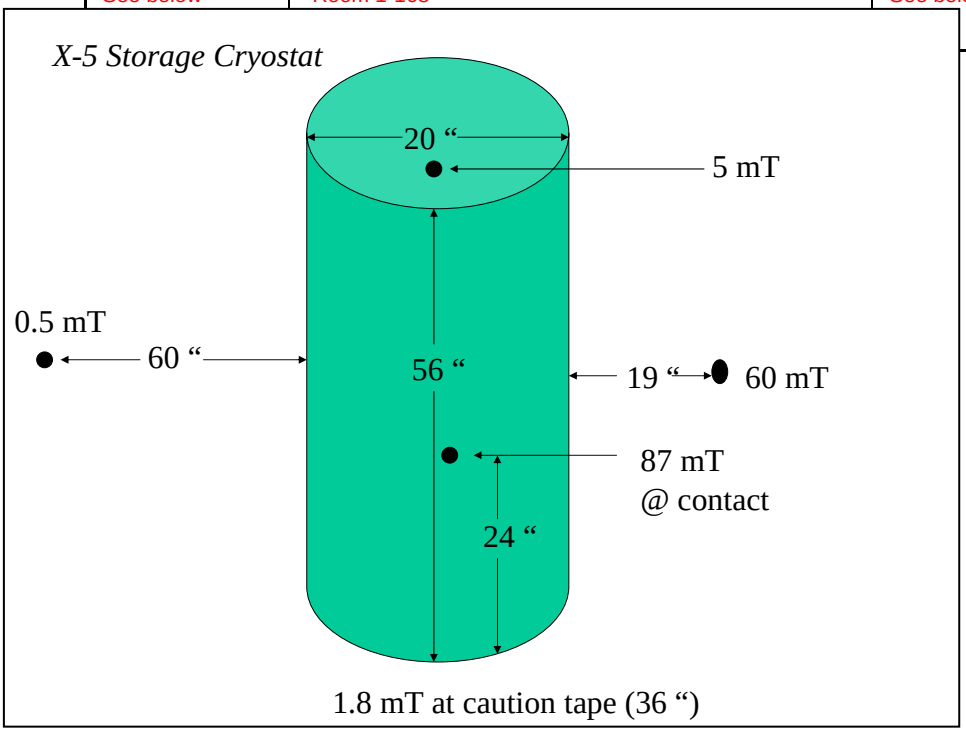
INSTRUMENT: Metrolab	MODEL: THM 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 10/28/2002	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See below	Room 1-168	See below	Magnet operating at ~8.7 Tesla



Field Strength Measurement Record	
DATE: 8/18/2003	**SURVEYOR: R. Zantopp, assisted by Chris Bade of X5 staff.**

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BNL Static Magnetic Fields Exposure Form

Part B: Field Strength Measurement Record

I. AREA INFORMATION		
DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 Transfer cryostat		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION		
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 01/26/2004	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

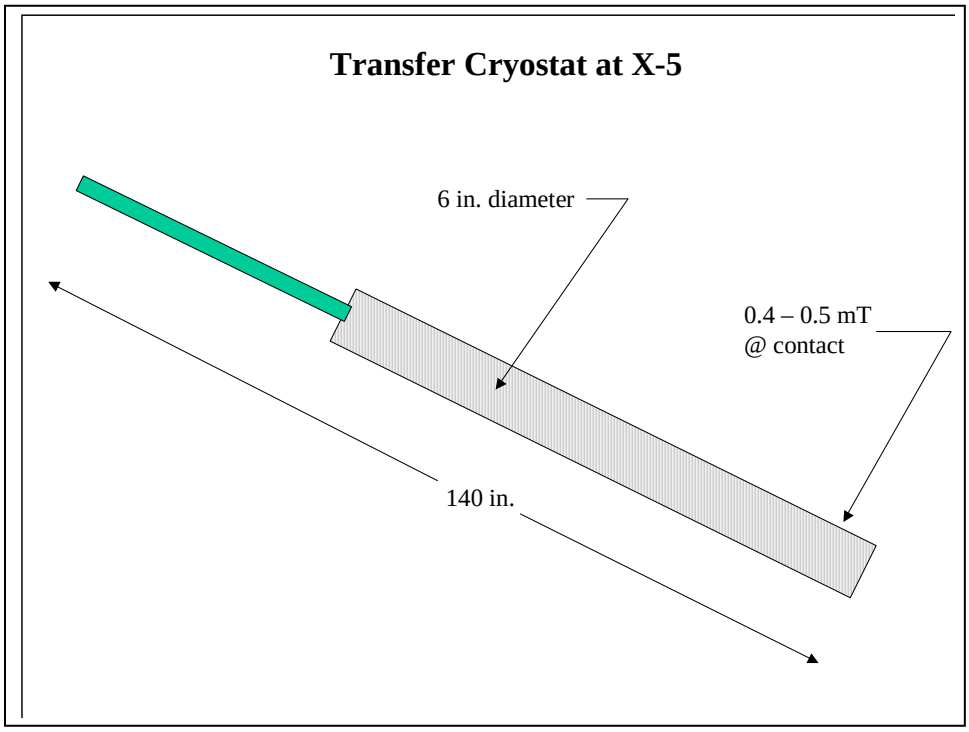
III. SAMPLING INFORMATION & RESULTS	
HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-168	See below	Magnet operating at 175 gauss

Field Strength Measurement Record

DATE: 5/28/2004	SURVEYOR: R. Zantopp



BROOKHAVEN NATIONAL LABORATORY

BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

I. AREA INFORMATION		
DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 In-Beam Cryostat		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION		
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 01/26/2004	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

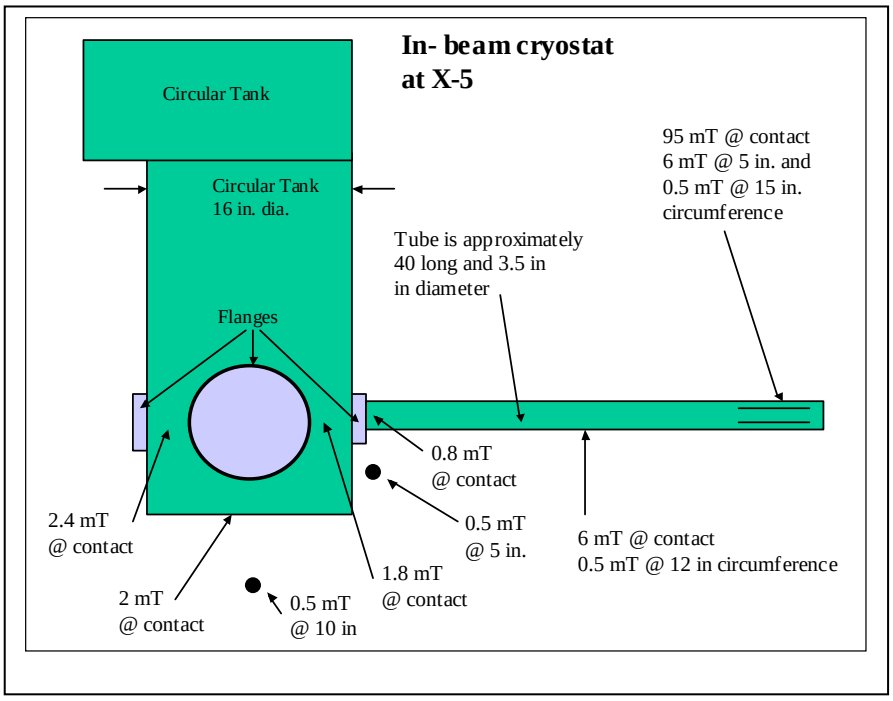
III. SAMPLING INFORMATION & RESULTS	
HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-168	See below	Magnet operating at 1 Tesla NOTE: when tube is inserted into detector, contact with the tube is not possible.

Forward the original form to the Static Magnetic Fields Subject Matter Expert, copies to your ES&H Coordinator and Facility Support Representative. Retain a copy in your files. Update and resubmit the assessment when changes occur.

FILE CODE: IH95SR. FORM IH-SMF (v1.0)



BNL Static Magnetic Fields Exposure Form
Part C: Employee Exposure Record

Employee Exposure Record

DATE: May 20, 2004	COMPLETED BY: Nicholas F. Gmür – **No medical issues**

I. AREA INFORMATION		
DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168, 169
SOURCE: X5 cryostats		

NOTE: MEASUREMENTS OR CALCULATIONS IDENTIFY THE INDIVIDIUALS BELOW TO HAVE THE POTENTIAL FOR EXCEEDING REGULATORY EXPOSURES LEVELS.

II. EMPLOYEE INFORMATION

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

Forward the original form to the Static Magnetic Fields Subject Matter Expert, copies to the Occupational Medicine Clinic, your ES&H Coordinator, and Facility Support Representative. Retain a copy in your files. Update and resubmit the assessment when changes occur.